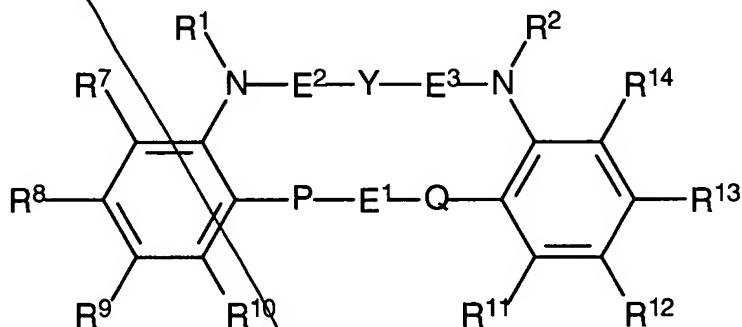


What is claimed is:

1. A compound of the formula



wherein

P and Q are independently O, S, or NR³, where each R³ is independently H or C₁-C₆ alkyl;

Y is O, S, or NR⁴, where R⁴ is H; or is -L-R_x, -L-S_c, or -L-DYE; or is C₁-C₁₈ alkyl or an aryl or heteroaryl ring system, which alkyl or ring system is optionally substituted by halogen, azido, nitro, nitroso, amino, C₁-C₆ alkylamino, C₂-C₁₂ dialkylamino, cyano, -L-R_x, -L-S_c, or -L-DYE; or by C₁-C₆ alkyl or C₁-C₆ alkoxy that is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸; wherein

R¹⁵ is H or C₁-C₆ alkyl; or -L-R_x, -L-S_c, or -L-DYE;

R¹⁶ is H, a C₁-C₆ alkyl, a benzyl, a biologically compatible esterifying group, a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE;

R¹⁷ and R¹⁸ are independently H, C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE; or R¹⁷ and R¹⁸ taken in combination form a 5- or 6-membered aliphatic ring that optionally incorporates an oxygen atom;

each L is independently a covalent linkage;

each R_x is independently a reactive functional group that is an acrylamide, an activated ester of a carboxylic acid, an acyl azide, an acyl nitrile, an aldehyde, an alkyl halide, an anhydride, an aniline, an aryl halide, an azide, an aziridine, a boronate, a diazoalkane, a haloacetamide, a halotriazine, a hydrazine, an imido ester, an isocyanate, an isothiocyanate, a maleimide, a phosphoramidite, a reactive platinum complex, a silyl halide, a sulfonyl halide, or a thiol;

each S_c is independently a conjugated substance;

DYE is a chemical moiety with an absorption maximum beyond 320 nm;

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E¹, E², and E³ are independently $-(CR_2^5)_n-$, or $-(C(O)CH_2)_n-$, where n = 2-4, and each R⁵ is independently H or CH₃, or two R⁵ moieties on adjacent carbons of one or more of E¹, E² or E³, when taken in combination, form a 5- or 6-membered aliphatic ring;

R¹ and R² are independently H; or -L-R_x, -L-S_c, or -L-DYE; or C₁-C₁₈ alkyl or C₇-C₁₈ arylalkyl, each of which is optionally substituted by halogen, azido, nitro, nitroso, amino, hydroxy, cyano, or by an aryl or heteroaryl ring system; or by -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, -(C=O)-NR¹⁷R¹⁸; or by C₁-C₆ alkylamino, C₂-C₁₂ dialkylamino; or by C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, -(C=O)-NR¹⁷R¹⁸;

R⁷-R¹⁴ are independently H, halogen, azido, nitro, nitroso, amino, cyano, -L-R_x, -L-S_c, -L-DYE; or C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸;

or any two adjacent substituents R⁷-R¹⁴, taken in combination, form a fused six-membered benzo moiety, which is optionally substituted by halogen, azido, nitro, nitroso, amino, cyano, -L-R_x, -L-S_c, or -L-DYE; or C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is optionally substituted by halogen, amino, hydroxy, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸;

or any two adjacent substituents R⁷-R¹⁴, taken in combination with each other, and with the aromatic ring they are bound to, form a fused DYE;

provided that said compound is substituted by at least one -L-DYE, -L-R_x, or -L-S_c at R¹, R², R³, R⁷, R⁸, R⁹, R¹⁰, R¹¹, R¹², R¹³, or R¹⁴; or at least two of R⁷-R¹⁴, taken in combination, form a fused DYE.

2. A compound, as claimed in Claim 1, wherein each R⁵ is H and each n is 2.

5 3. A compound, as claimed in Claim 1, wherein Y is NR⁴.

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5 4. A compound, as claimed in Claim 1 wherein P and Q are O.

5 5. A compound, as claimed in Claim 4, wherein Y is O.

6. A compound, as claimed in Claim 5, wherein said compound is substituted by only one -L-R_x, or -L-S_c, that is bound at R⁸, R⁹, R¹², or R¹³.

10 7. A compound, as claimed in Claim 1, wherein R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by cyano, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸.

8. A compound, as claimed in Claim 1, wherein R⁸ and R⁹, and optionally R¹² and R¹³, taken in combination, form a fused DYE that is a substituted or unsubstituted benzofuran.

15 9. A compound, as claimed in Claim 1, wherein said compound is substituted by exactly two DYE or fused DYE moieties.

10. A compound, as claimed in Claim 1, wherein said compound is substituted by exactly one -L-DYE moiety at R⁹, and is optionally additionally substituted by exactly one -L-R_x or exactly one -L-S_c.

20 11. A compound, as claimed in Claim 1, wherein each L is independently a single covalent bond, or a covalent linkage that is linear or branched, cyclic or heterocyclic, saturated or unsaturated, having 1-20 nonhydrogen atoms selected from the group consisting of C, N, P, O and S; and are composed of any combination of ether, thioether, amine, ester, carboxamide, sulfonamide, hydrazide bonds and aromatic or heteroaromatic bonds.

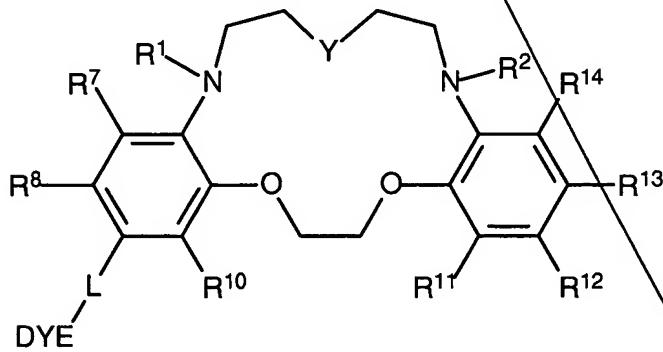
12. A compound, as claimed in Claim 11, wherein L is a single covalent bond or has the formula $-(CH_2)_d(COCONH(CH_2)_e)_z-$ or $-O(CH_2)_d(COCONH(CH_2)_e)_z-$, where d is an integer from 0-5, e is an integer from 1-5 and z is 0 or 1.

13. A compound, as claimed in Claim 1, that is substituted by at least one S_c , wherein
each S_c is an amino acid, a peptide, a protein, a polysaccharide, a nucleoside, a
nucleotide, an oligonucleotide, a nucleic acid, a hapten, a psoralen, a drug, a
hormone, a lipid, a lipid assembly, a synthetic polymer, a polymeric microparticle, a
biological cell or a virus.

14. A compound, as claimed in Claim 1, wherein said compound is substituted by exactly one S_c that is a protein, a polysaccharide, a biotin, or a silica.

15. A compound, as claimed in Claim 1, that is substituted by at least one $-L-R_x$,
wherein R_x is a succinimidyl ester of a carboxylic acid, a haloacetamide, a hydrazine,
an isothiocyanate, a maleimide, an aliphatic amine, a silyl halide, or a psoralen.

16. A compound, as claimed in Claim 1, having the formula



wherein Y is O or NR⁴.

17. A compound, as claimed in Claim 16, wherein DYE is an indole, a coumarin, a stilbene, a xanthene, an oxazine, or a polyazaindacene.

18. A compound, as claimed in Claim 17, wherein DYE is a fluorescein, a rhodamine, a
20 rhodol, a polyazaindacene, an oxazine, a 3*H*-xanthen-6-ol-3-one, a 6-amino-3*H*-xanthen-3-one, or a 6-amino-3*H*-xanthen-3-imine, and L is a single covalent bond.

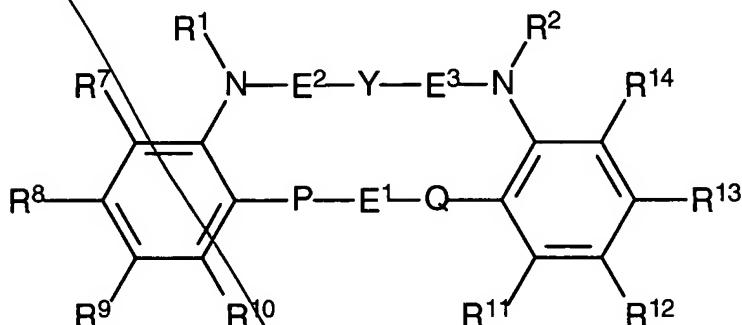
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19. A compound, as claimed in Claim 16, wherein R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸.

20. A compound, as claimed in Claim 19, wherein R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by -(C=O)-O-R¹⁶, where each R¹⁶ is H, C₁-C₆ alkyl, an alpha-acyloxymethyl, a t-butyldimethyldimethylsilyl, or a biologically compatible salt.

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21. A composition of matter comprising a compound of the formula:



wherein

P and Q are independently O, S, or NR³, where each R³ is independently H or C₁-C₆ alkyl;

Y is O, S, or NR⁴, where R⁴ is H; or is -L-R_x, -L-S_c, or -L-DYE; or is C₁-C₁₈ alkyl or an aryl or heteroaryl ring system, which alkyl or ring system is optionally substituted by halogen, azido, nitro, nitroso, amino, C₁-C₆ alkylamino, C₂-C₁₂ dialkylamino, cyano, -L-R_x, -L-S_c, or -L-DYE; or by C₁-C₆ alkyl or C₁-C₆ alkoxy that is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸; wherein

R¹⁵ is H or C₁-C₆ alkyl; or -L-R_x, -L-S_c, or -L-DYE;

R¹⁶ is H, a C₁-C₆ alkyl, a benzyl, a biologically compatible esterifying group, a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE;

R¹⁷ and R¹⁸ are independently H, C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE; or R¹⁷ and R¹⁸ taken in combination form a 5- or 6-membered aliphatic ring that optionally incorporates an oxygen atom;

each L is independently a covalent linkage;

each R_x is independently a reactive functional group;

each S_c is independently a conjugated substance;

DYE is a chemical moiety with an absorption maximum beyond 320 nm;

~~E¹, E², and E³ are independently -(CR⁵)_n-, where n = 2-4, and each R⁵ is independently H or CH₃, or two R⁵ moieties on adjacent carbons of one or more of E¹, E² or E³, when taken in combination, form a 5- or 6-membered aliphatic ring;~~

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~~R¹ and R² are independently H; or -L-R_x, -L-S_c, or -L-DYE; or C₁-C₁₈ alkyl or C₇-C₁₈ arylalkyl, each of which is optionally substituted by halogen, azido, nitro, nitroso, amino, hydroxy, cyano, or by an aryl or heteroaryl ring system; or by -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, -(C=O)-NR¹⁷R¹⁸; or by C₁-C₆ alkylamino, C₂-C₁₂ dialkylamino; or by C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, -(C=O)-NR¹⁷R¹⁸;~~

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~~R⁷-R¹⁴ are independently H, halogen, azido, nitro, nitroso, amino, cyano, -L-R_x, -L-S_c, -L-DYE; or C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸;~~

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~~or any two adjacent substituents R⁷-R¹⁴, taken in combination, form a fused six-membered benzo moiety, which is optionally substituted by halogen, azido, nitro, nitroso, amino, cyano, -L-R_x, -L-S_c, or -L-DYE; or C₁-C₆ alkyl or C₁-C₆ alkoxy, each of which is optionally substituted by halogen, amino, hydroxy, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸;~~

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~~or any two adjacent substituents R⁷-R¹⁴, taken in combination with each other, and with the aromatic ring they are bound to, form a fused DYE;~~

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~~provided that said compound is substituted by at least one -L-DYE moiety at one or more of R¹, R², R³, and R⁷-R¹⁴; or at least two of R⁷-R¹⁴, taken in combination, form a fused DYE.~~

22. A composition, as claimed in Claim 21, wherein each R^6 of the compound is H and each n is 2.

23. A composition, as claimed in Claim 21, wherein each R_x of the compound is independently a reactive functional group that is an acrylamide, an activated ester of a carboxylic acid, an acyl azide, an acyl nitrile, an aldehyde, an alkyl halide, an anhydride, an aniline, an aryl halide, an azide, an aziridine, a boronate, a diazoalkane, a haloacetamide, a halotriazine, a hydrazine, an imido ester, an isocyanate, an isothiocyanate, a maleimide, a phosphoramidite, a reactive platinum complex, a silyl halide, a sulfonyl halide, or a thiol.

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24. A composition, as claimed in Claim 21, wherein each P and Q on the compound are O.

10 25. A composition, as claimed in Claim 24, wherein each Y on the compound is O.

26. A composition, as claimed in Claim 25, wherein said compound is substituted by only one $-L-R_x$, or $-L-S_c$, that is bound at R^8 , R^9 , R^{12} , or R^{13} .

15 27. A composition, as claimed in Claim 25, wherein R^1 and R^2 are C_1-C_6 alkyl that are substituted one or more times by cyano, $-(C=O)-O-R^{16}$, or $-(C=O)-NR^{17}R^{18}$.

28. A composition, as claimed in Claim 21, wherein R^8 and R^9 , and optionally R^{12} and R^{13} , taken in combination, form a fused DYE that is a substituted or unsubstituted benzofuran.

20 29. A composition, as claimed in Claim 21, wherein said compound is substituted by exactly two DYE or fused DYE moieties.

30. A composition, as claimed in Claim 21, wherein said compound is substituted by exactly one $-L$ -DYE moiety at R^9 , and is optionally additionally substituted by exactly one $-L-R_x$ or exactly one $-L-S_c$.

25 31. A composition, as claimed in Claim 21, wherein each L of the compound is independently a single covalent bond, or a covalent linkage that is linear or branched, cyclic or heterocyclic, saturated or unsaturated, having 1-20 nonhydrogen atoms selected from the group consisting of C, N, P, O and S; and are composed of

any combination of ether, thioether, amine, ester, carboxamide, sulfonamide, hydrazide bonds and aromatic or heteroaromatic bonds.

32. A composition, as claimed in Claim 31, wherein each L of the compound is a single covalent bond or has the formula $-(\text{CH}_2)_d(\text{CONH}(\text{CH}_2)_e)_z-$ or $-\text{O}(\text{CH}_2)_d(\text{CONH}(\text{CH}_2)_e)_z-$, where d is an integer from 0-5, e is an integer from 1-5 and z is 0 or 1.

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33. A composition, as claimed in Claim 21, wherein each S_c of the compound is an amino acid, a peptide, a protein, a polysaccharide, a nucleoside, a nucleotide, an oligonucleotide, a nucleic acid, a hapten, a psoralen, a drug, a hormone, a lipid, a lipid assembly, a synthetic polymer, a polymeric microparticle, a biological cell or a virus.

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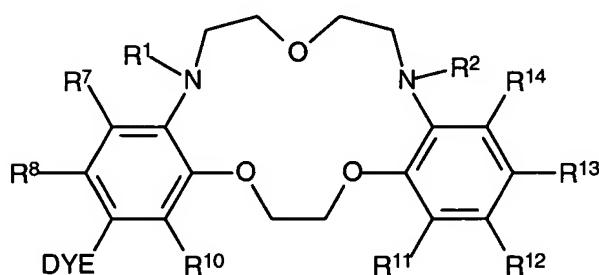
34. A composition, as claimed in Claim 21, wherein said compound is substituted by exactly one S_c , which S_c is a protein, a polysaccharide, a biotin, or a silica.

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35. A composition, as claimed in Claim 21, wherein said compound is substituted by exactly one R_x , which R_x is a succinimidyl ester of a carboxylic acid, a haloacetamide, a hydrazine, an isothiocyanate, a maleimide, an aliphatic amine, a silyl halide, or a psoralen.

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36. A composition, as claimed in Claim 21, where the compound has the formula:



where R^1 , R^2 , R^7 , R^8 , and R^{10} are not $-L\text{-DYE}$, and no more than one, and optionally none, of R^{11} - R^{14} is $-L\text{-DYE}$.

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37. A composition, as claimed in Claim 36, wherein each DYE on the compound is a fluorescein, a rhodamine, a rhodol, a polyazaindacene, an oxazine, a 3*H*-xanthan-6-ol-3-one, a 6-amino-3*H*-xanthan-3-one, or a 6-amino-3*H*-xanthan-3-imine.

38. A composition, as claimed in Claim 36, wherein R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸.

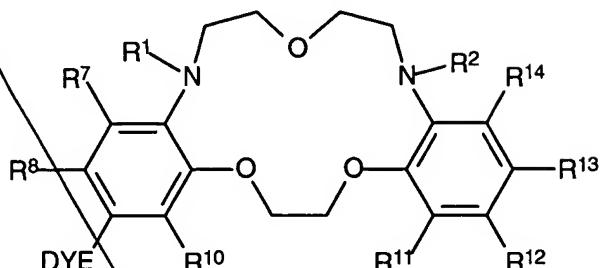
39. A composition, as claimed in Claim 38, wherein R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by -(C=O)-O-R¹⁶, where each R¹⁶ is H, an alpha-
5 acyloxymethyl, a t-butyldimethyldimethylsilyl, or a biologically compatible salt.

40. A composition, as claimed in Claim 36, further comprising a metal ion that is Ca²⁺,
Na⁺, K⁺, or Zn²⁺ associated with said compound.

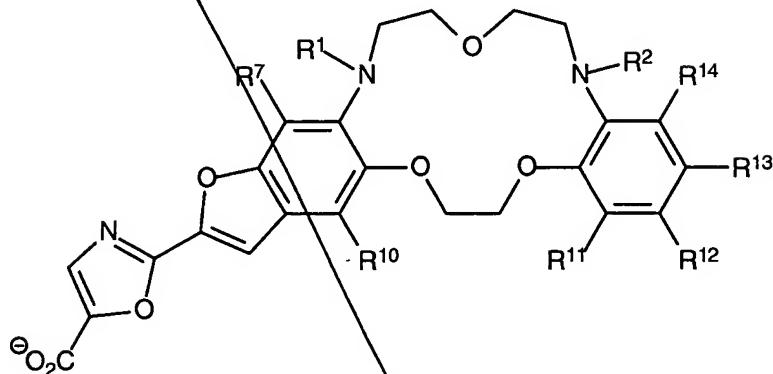
41. A composition, as claimed in Claim 21, further comprising a natural or synthetic
polymer or glass.

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42. A compound having the formula:



or the formula:



wherein

R¹ and R² are C₁-C₆ alkyl that are substituted one or more times by cyano, an aryl or heteroaryl ring system, or by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸, where

R¹⁶ is H, a C₁-C₆ alkyl, a benzyl, a biologically compatible esterifying group, or a biologically compatible salt;

10 R¹⁷ and R¹⁸ are independently H, C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, an alpha-acyloxyethyl, or a biologically compatible salt;

R⁷-R¹⁰, and R¹¹-R¹⁴, where present, are independently H, chloro, bromo, fluoro, nitro, amino, or cyano; or C₁-C₆ alkyl or C₁-C₆ alkoxy that is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁶, -(SO₂)-O-R¹⁶, -(C=O)-R¹⁶, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸; and

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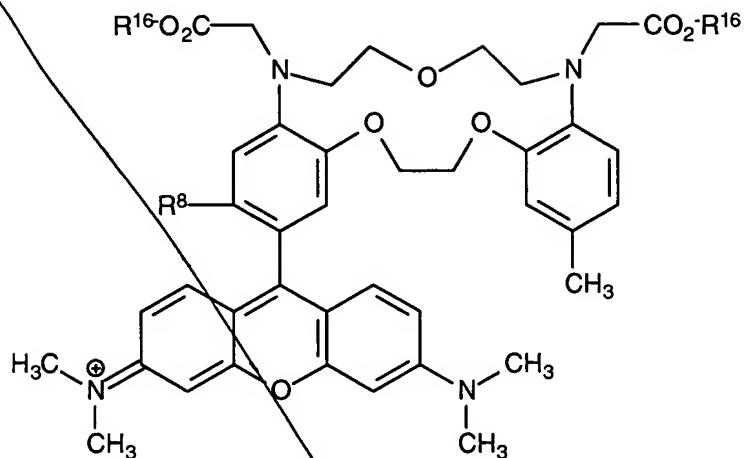
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DYE, where present is a polyazaindacene, an oxazine, or a xanthene, which is optionally substituted by halogen, nitro, sulfo, cyano, an aryl or heteroaryl ring system, or benzo, or alkyl, perfluoroalkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, arylalkyl, or acyl, the alkyl portions of which contain fewer than 20 carbons.

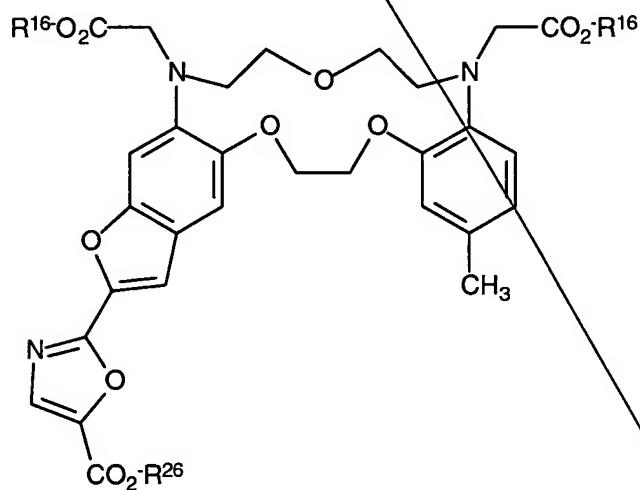
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43. A compound having the formula:

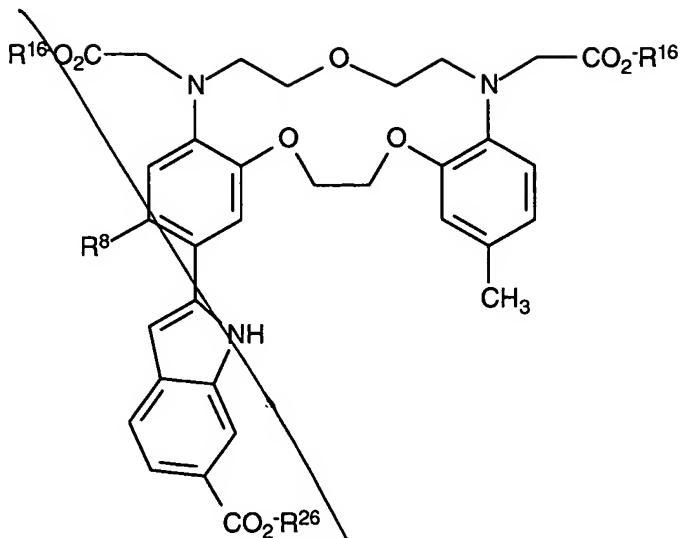


or the formula

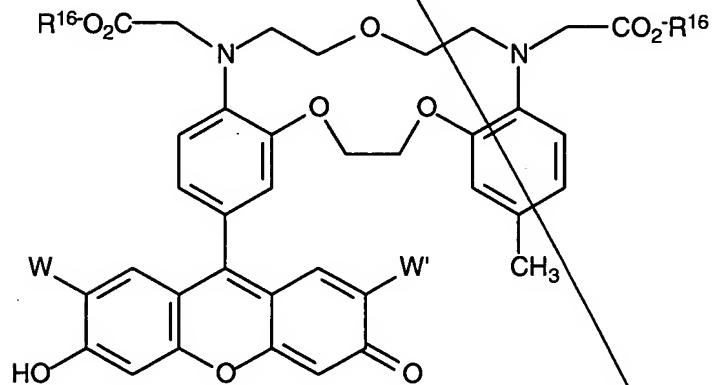


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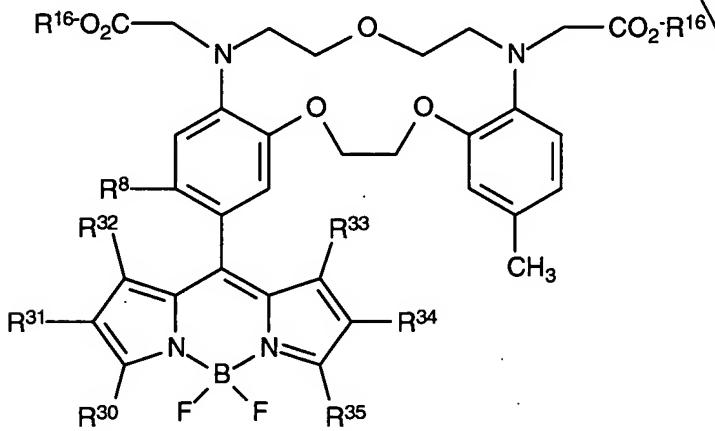
or the formula:



or the formula:



or the formula:



wherein

~~R⁸, where present, is independently H or a C₁-C₆ alkyoxy, which is optionally substituted by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸;~~

~~5 R¹⁶ and R²⁶, where present, are independently H, a C₁-C₆ alkyl, a benzyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt;~~

~~Sch b1 R¹⁷ and R¹⁸, where present, are independently H, a C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, or a biologically compatible salt;~~

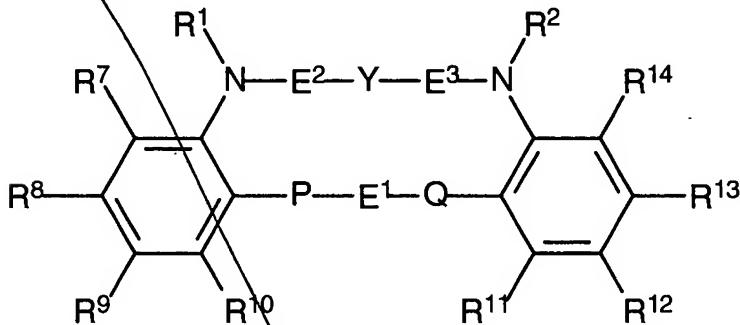
~~W and W', where present, are independently F or Cl;~~

~~10 R³⁰-R³⁵, where present, are independently H, halogen, nitro, sulfo, cyano, alkyl, perfluoroalkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, arylalkyl, or acyl, wherein the alkyl portions of each contain fewer than 20 carbons; or an aryl or heteroaryl ring system; or adjacent substituents R³¹ and R³², and adjacent substituents R³³ and R³⁴, when taken in combination form a fused benzo ring that is optionally substituted by hydrogen, halogen, nitro, sulfo, cyano, alkyl, perfluoroalkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, alkylthio, alkylamido, amino, monoalkylamino or dialkylamino wherein the alkyl portions of each contain fewer than 20 carbons.~~

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44. A method of detecting a target cationic metal ion in a sample, comprising:

a) adding to said sample, in an amount sufficient to generate a detectable optical response when said target ion is present, a compound having the formula:



wherein

P and Q are independently O, S, or NR³, where each R³ is independently H or C₁-C₆ alkyl;

Y is O, S, or NR⁴, where R⁴ is H; or is -L-R_x, -L-S_c, or -L-DYE; or is C₁-C₁₈ alkyl or an aryl or heteroaryl ring system, which alkyl or ring system is optionally substituted by halogen, azido, nitro, nitroso, amino, C₁-C₆ alkylamino, C₂-C₁₂ dialkylamino, cyano, -L-R_x, -L-S_c, or -L-DYE; or by C₁-C₆ alkyl or C₁-C₆ alkoxy that is itself optionally substituted by halogen, amino, hydroxy, -(SO₂)-R¹⁵, -(SO₂)-O-R¹⁵, -(C=O)-R¹⁵, -(C=O)-O-R¹⁶, or -(C=O)-NR¹⁷R¹⁸; wherein

15 R¹⁵ is H or C₁-C₆ alkyl; or -L-R_x, -L-S_c, or -L-DYE;

R¹⁶ is H, a C₁-C₆ alkyl, a benzyl, a biologically compatible esterifying group, a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE;

20 R¹⁷ and R¹⁸ are independently H, C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt; or -L-R_x, -L-S_c, or -L-DYE; or R¹⁷ and R¹⁸ taken in combination form a 5- or 6-membered aliphatic ring that optionally incorporates an oxygen atom;

each L is independently a covalent linkage;

each R_x is independently a reactive functional group;

each S_c is independently a conjugated substance;

DYE is a chemical moiety with an absorption maximum beyond 320 nm;

5 E^1 , E^2 , and E^3 are independently $-(CR^5_2)_n-$, where $n = 2-4$, and each R^5 is independently H or CH_3 , or two R^5 moieties on adjacent carbons of one or more of E^1 , E^2 or E^3 , when taken in combination, form a 5- or 6-membered aliphatic ring;

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R¹ and R^2 are independently H; or $-L-R_x$, $-L-S_c$, or $-L-DYE$; or C_1-C_{18} alkyl or C_7-C_{18} arylalkyl, each of which is optionally substituted by halogen, azido, nitro, nitroso, amino, hydroxy, cyano, or by an aryl or heteroaryl ring system; or by $-(SO_2)-R^{15}$, $-(SO_2)-O-R^{15}$, $-(C=O)-R^{15}$, $-(C=O)-O-R^{16}$, $-(C=O)-NR^{17}R^{18}$; or by C_1-C_6 alkylamino, C_2-C_{12} dialkylamino; or by C_1-C_6 alkyl or C_1-C_6 alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, $-(SO_2)-R^{15}$, $-(SO_2)-O-R^{15}$, $-(C=O)-R^{15}$, $-(C=O)-O-R^{16}$, $-(C=O)-NR^{17}R^{18}$;

15 R^7-R^{14} are independently H, halogen, azido, nitro, nitroso, amino, cyano, $-L-R_x$, $-L-S_c$, $-L-DYE$; or C_1-C_6 alkyl or C_1-C_6 alkoxy, each of which is itself optionally substituted by halogen, amino, hydroxy, $-(SO_2)-R^{15}$, $-(SO_2)-O-R^{15}$, $-(C=O)-R^{15}$, $-(C=O)-O-R^{16}$, or $-(C=O)-NR^{17}R^{18}$;

20 or any two adjacent substituents R^7-R^{14} , taken in combination, form a fused six-membered benzo moiety, which is optionally substituted by halogen, azido, nitro, nitroso, amino, cyano, $-L-R_x$, $-L-S_c$, or $-L-DYE$; or C_1-C_6 alkyl or C_1-C_6 alkoxy, each of which is optionally substituted by halogen, amino, hydroxy, $-(C=O)-R^{15}$, $-(C=O)-O-R^{16}$, or $-(C=O)-NR^{17}R^{18}$;

25 or any two adjacent substituents R^7-R^{14} , taken in combination with each other, and with the aromatic ring they are bound to, form a fused DYE;

provided that said compound is substituted by at least one $-L-DYE$ moiety at one or more of R^1 , R^2 , R^3 , and R^7-R^{14} ; or at least two of R^7-R^{14} , taken in combination, form a fused DYE;

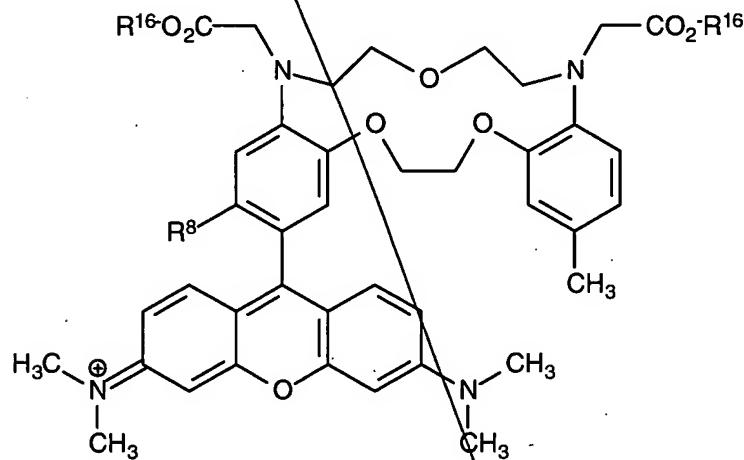
b) illuminating said sample to generate said detectable optical response that indicates that said target ion is present.

45. A method, as claimed in Claim 44, wherein said detectable optical response is a fluorescence response.

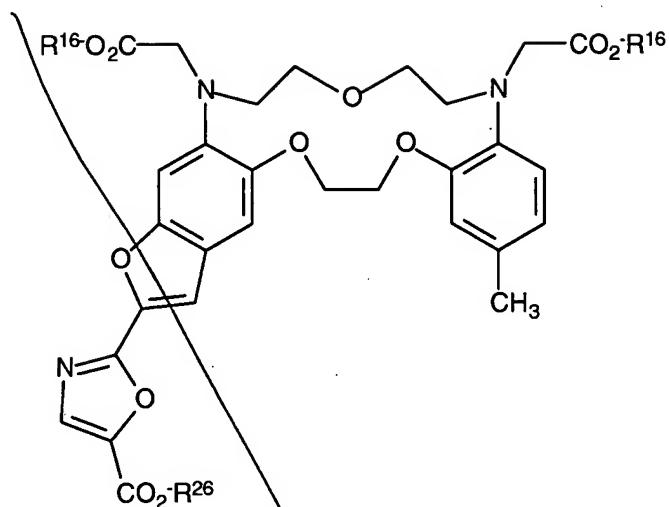
5 46. A method, as claimed in Claim 45, wherein the step of illuminating is performed in conjunction with a fluorometer, fluorescence microscope, laser scanner, flow cytometer, a microfluidic device, or a fiber optic probe.

47. A method, as claimed in Claim 44, wherein said target metal ion is Na^+ , K^+ , Ca^{2+} , or Zn^{2+} .

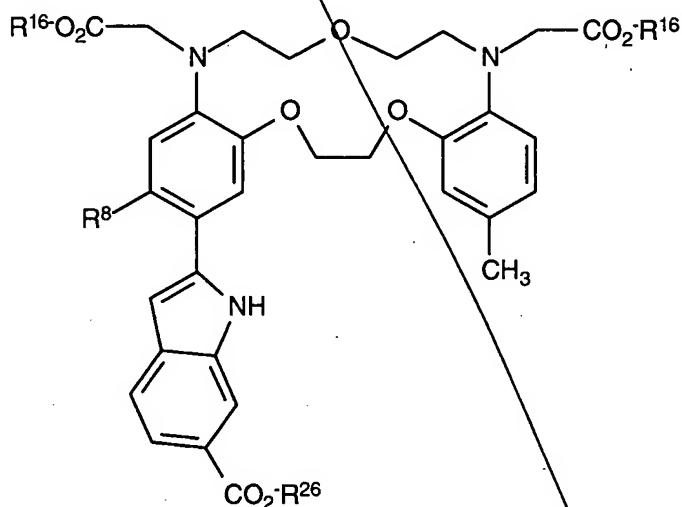
10 48. A method, as claimed in Claim 44, wherein said compound has the formula:



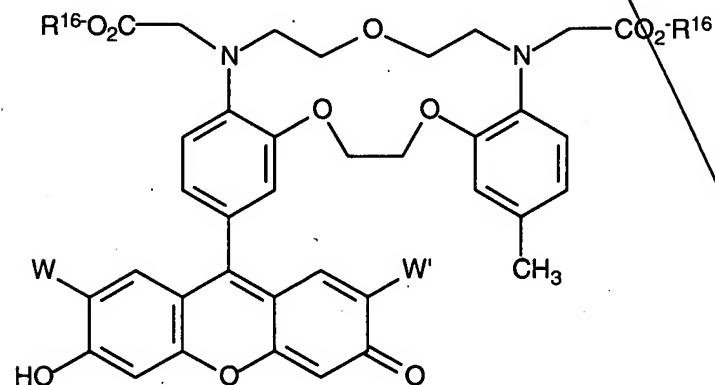
or the formula:



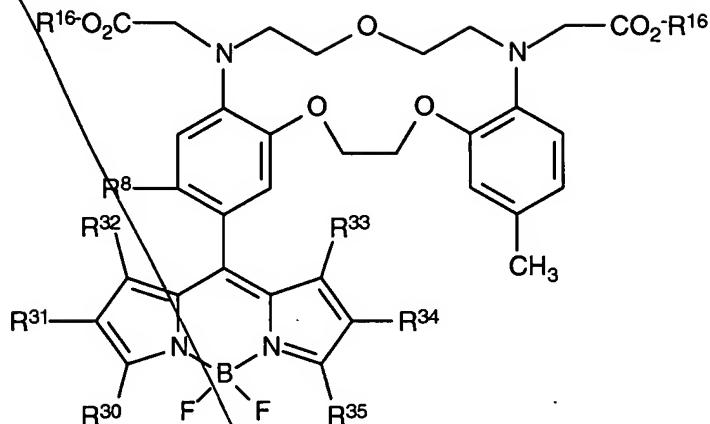
or the formula:



or the formula:



or the formula:



wherein

R⁸, where present, is independently H or a C₁-C₆ alkyloxy, which is optionally substituted by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸;

R¹⁶ and R²⁶, where present, are independently H, a C₁-C₆ alkyl, a benzyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt;

R¹⁷ and R¹⁸, where present, are independently H, a C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, or a biologically compatible salt;

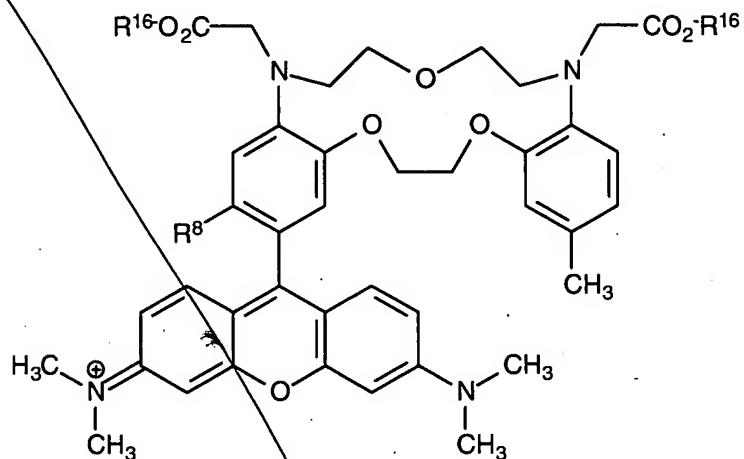
W and W', where present, are independently F or Cl;

R³⁰-R³⁵, where present, are independently H, halogen, nitro, sulfo, cyano, alkyl, perfluoroalkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, arylalkyl, or acyl, wherein the alkyl portions of each contain fewer than 20 carbons; or an aryl or heteroaryl ring system.

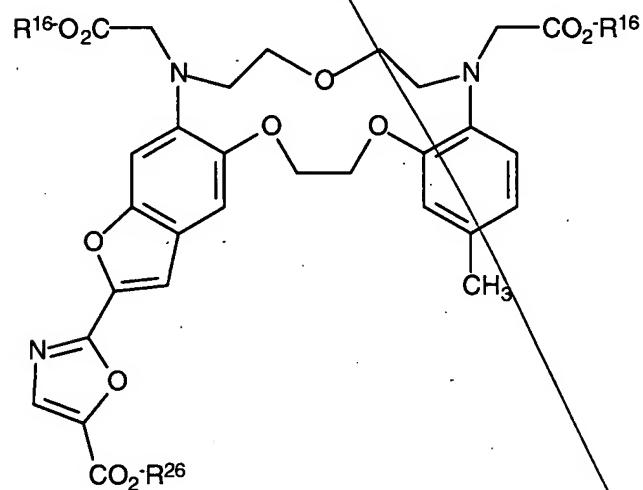
15 49. A method, as claimed in Claim 48, wherein said target metal ion is Na⁺ or K⁺.

50. A method, as claimed in Claim 44, wherein said sample further comprises living cells or biological fluids.

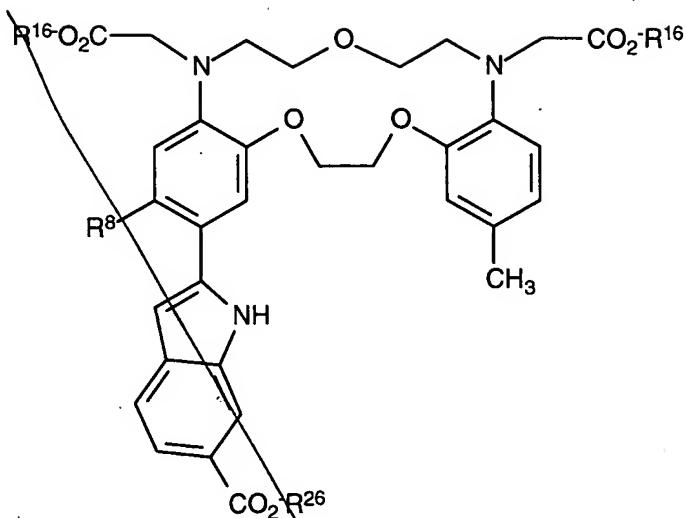
51. A kit for the detection or quantification of a target metal ion, comprising a compound having the formula:



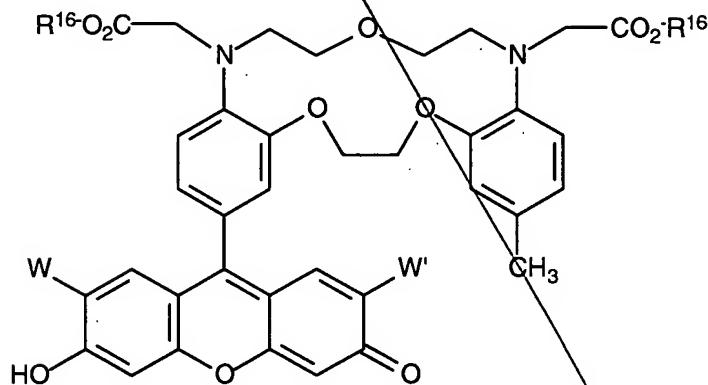
or the formula:



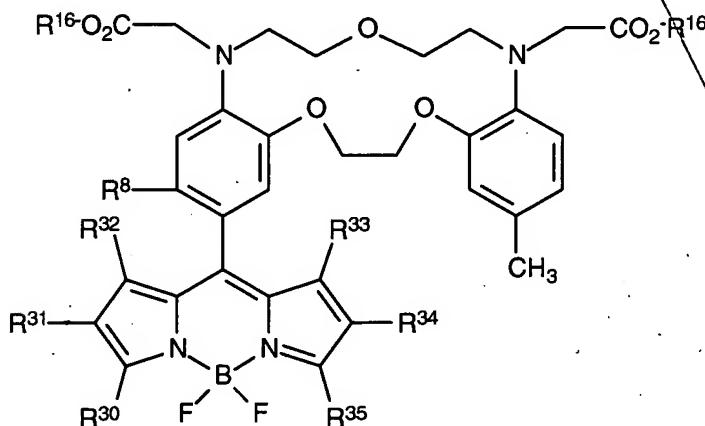
or the formula:



or the formula:



or the formula:



wherein

~~R⁸, where present, is independently H or a C₁-C₆ alkoxy, which is optionally substituted by -(C=O)-O-R¹⁶ or -(C=O)-NR¹⁷R¹⁸;~~

~~R¹⁶ and R²⁶, where present, are independently H, a C₁-C₆ alkyl, a benzyl, an alpha-acyloxyalkyl, a t-butyldimethylsilyl, or a biologically compatible salt;~~

5 ~~R¹⁷ and R¹⁸, where present, are independently H, a C₁-C₆ alkyl, C₁-C₆ carboxyalkyl, or a biologically compatible salt;~~

*Sub
B1*
W and W', where present, are independently F or Cl;

~~R³⁰-R³⁵, where present, are independently H, halogen, nitro, sulfo, cyano, alkyl, perfluoroalkyl, alkoxy, alkenyl, alkynyl, cycloalkyl, arylalkyl, or acyl, wherein the alkyl portions of each contain fewer than 20 carbons; or an aryl or heteroaryl ring system;~~

and comprising one or more components selected from the group consisting of:

- a) a calibration standard of a target ion;
- b) an ionophore;
- c) a fluorescence standard;
- d) an aqueous buffer solution; and
- e) an organic solvent.